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Philadelphia March 1828
On the Identity of Electricity
and Nervous Influence

By Burton Randall principles
and practice of medicine, &c
of Annapolis Md - practice

For the Degree of Doctor of Medicine
In the University of Pennsylvania

Presented 5th January

A.D 1828

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On the Identity of Electricity and the Nervous Influence.

No part of the anatomy and physiology of man is more important, than the nervous system. It is this system which forms the great characteristic between the vegetable and animal kingdoms. It is its greater development, which renders one animal superior to another; and, and it is its perfection which renders man superior to the brute creation.

It is not my intention, in this Thesis, to describe the anatomical structure of the brain, the great organ of intellect, nor, of the nerves, which are the means of communication between the brain and other organs of the body, but, to offer such facts and arguments, as I have been able to collect, to prove the Identity of electricity and the nervous influence.

Let us inquire what is this agent, this nervous influence or fluid, which forms

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the connecting link between mind & matter,
between the mere material machine and
the immaterial and immortal principle
of man. Is it a solid, is it a fluid, or is it
an invisible fluid; as magnetism, heat, electricity
& galvanism?

We know, that it is through the
the nerves that an impression, made on one of
the senses the sense of touch, is conveyed to the
centre of perception, and makes an impression,
called a sensation; because if this nervous fibre
is destroyed, no impression can be conveyed.
We further know, that the power, by which the
will acts through the centre of perception, on
certain muscles, for the performance of certain
motions or functions, is conveyed by nervous
filaments, because, that power may be destroy-
ed or modified by any thing which interrupts
this nervous connexion.

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But in neither case, do we know the exact medium of this communication.

It has been asserted by some, that a nerve is an assemblage of small thin cords, assimilated by their tension to solid bodies, and that an impression, made ^{at} one end, conveys a sensation to the ^{other; in the case of} as ^{on a} rod, or tense string of a musical instrument.

Now, this simple fact, that the nerves are non-tense, and must necessarily be relaxed during the flexions of the limbs, at once disproves this mechanical explanation.

Others assert, that the nervous fibre is a tube, filled with a gelatinous or fluid matter, which is a good conductor of impressions or impulses; and, that sensations are conveyed through this fluid, as in the labyrinth of the ear. It may be objected to this explanation, that it is by no means a

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determined fact in physiology, that the nerves are tubulated, much less has it been proved that they contain this gelatinous matter. Magendie says, he has repeatedly tried to ascertain whether the nervous fibers were tubes, but could never satisfy himself of the fact. However, this explanation is at once done away, by the recent experiments of Sir W. Phillips and others, which clearly establish ^{the fact} that impressions may be conveyed, though the nerve be divided, provided, the ends of the nerve be not too far separated.

Others believe, that the medium of this communication is a peculiar invisible fluid analogous to electricity or galvanism. Experiments recently made, have tended much to such a belief.

It had been long known, that a section of the pneumo-gastric nerve disturbed

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the functions of the lungs and stomach, but, until recently, the exact effect of this section had not been discovered.

By the experiments of Sir W. B. Ophry, in London, and Dr Boischat, in Paris, the following facts have been elicited.

1.st That, if a part of a nerve is cut, or the two ends of the divided nerve separated, the process of digestion is entirely suspended.

2.nd That the process of digestion, having been thus suspended, may be again established, to a certain extent, by bringing the two ends of the divided nerve into contact, or, by introducing between them a conductor of electricity.

3.rd That the process of digestion, having been suspended as in the first operation, may be again established, by

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by attaching, to the lower end of the divided nerve, the positive pole of a galvanic battery, the negative end being in connexion with the lower end of the stomach, ^{thus substituting} the galvanic for the nervous influence.

The following experiments were tried on horses by Brocchet, after having been frequently successful on smaller animals.

Three horses were selected, and all fed on oats after a long abstinence. In one, the nerves of the stomach were divided, and their ends ^{separately}, the second was left untouched. The third submitted to the following treatment, the nerves of the stomach were divided, and their ends separated, as in the first horse, the lower ends of the nerves were then connected with the positive pole of a galvanic battery, the negative pole being connected with the lower end of the stomach.

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The following were the unequivocal results:

In the horse, that had been left untouched
nearly all the food was digested and passed
from the stomach to the intestines.

In the horse whose nerves had been divided
and connected with positive galvanic pole,
the food was almost in the same state,
& in the horse that had been untouched

On the other hand; in the
horse, whose nerves had been divided &
had not been galvanised, little or no digestion
had taken place, three times as much
indigested food having been found in
his stomach, as in the stomachs of the
other two horses.

Do Breschet objects to this
theory, and endeavours to prove, that, when
produced by galvanism after the section
of the pneumo-gastric nerve, it is not by

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any chemical change, but by exciting the coats of the stomach; and, he has endeavoured to prove by experiment, that mechanical irritation has the same effect in a leper alewife.

But, to this opinion of Boerhaave, we may readily oppose the result of Dr. Philip's experiments who, says he has repeated the experiment of mechanical irritation, after the section of the ^{nervi} alluded to, and that the food exhibited no more appearance of digestion than when there was no mechanical irritation; although the experiment was continued for eight hours, the time the animal lived after the operation. Dr. M. Philip supports this with confidence, because he is perfectly acquainted with the appearance of the rabbit's stomach under those experiments, a rabbit being the animal operated on by Boerhaave.

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These experiments, therefore, if they do not prove that the galvanic fluid and nervous influence are identical, at least prove unequivocally, that in digestion, the one may be substituted for the other, a fact that had been long established so far as regards muscular actions, by galvanising executed criminals, and thereby, producing in them, violent and long continued muscular contractions.

The great difficulty has been with many, to comprehend how a fluid, which so far as we can judge, is produced by mechanical and chemical means alone, can be elicited by the brain, an organ in which no such actions can take place. But have we not analogous instances, in the secretion of the fluid, ^{that} in all warm blooded animals, And in light which is secreted by the Glowworm & Firefly?

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and yet, these facts are not doubted; although we cannot explain their phenomena.

However, as if to prevent our being left in doubt, as to the power of the brain to secrete the electric fluid, nature has furnished us with unequivocal instances of it in the Torpedo, and other electrical animals. It is well known, that the *Raija* *Torpedo*, the *Gymnotus* *Electricus*, & *Albionus* *Electricus*, have the power of giving out, at pleasure, violent electrical shocks; so much so, as to benumb, or destroy, smaller animals, and even man, when fairly exposed to their influence. Gray, for a long time, doubted whether this was purely an electrical phenomenon; but the fact is now established, beyond the possibility of doubt. By experiments, it has been proved, that these animals give out, at pleasure, successive shocks of electricity; and that this electricity differs, in no wise, from that elicited from an electrical machine.

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These facts having been established, the animal was for a long time considered a living electrical machine, and the electricity was supposed to be elicited by friction produced by muscular action. But it has been proved, by observation, that this impression is entirely erroneous; no muscular apparatus having been found, capable of producing the necessary friction, and no material which has the power of eliciting it by friction.

Besides it has been proved, that the animal has the power, when completely isolated, of continuing to exert the electrical fluid, as long as vitality exists, a power which no electrical machine possesses; for, in all cases, when electricity is elicited by friction the negative pole of the apparatus must be in connexion with the earth, or some other great electrical reservoir. It has been further discovered, that this animal has not the

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power of secreting this fluid, at pleasure; but, that it is collected, by some purely vital process, in isolated reservoirs in connexion with the conducting surface of its external integuments.

The immediate source of this fluid was, still in doubt, when Mr. Hunter clearly established, by dissections, that it was derived from the nerves and brain of the animal. He found, that the electrical apparatus of the animal consisted of a number hexagonal columns of a cartilaginous substance, filled with a glutinous substance completely isolated by cellular membrane from the surrounding parts of the animal, and receiving large nerves from the brain. This is the electrical reservoir, which receives the fluid secreted by the brain, through the large nervous branches connecting it with that organ.

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The apparatus, having but little sensation or motion, would have required but small nerves for its support, if it had not been for the wise provision of nature, which thus enables the animal to lay up a supply of electricity for its defence, and the destruction of its prey.

Thus we have clearly established these important facts, that animals have the power of secreting electricity, that the brain is the organ of this secretion, and that the nerves are its conductors.

In the 8th volume of the Medico-Chirurgical Review, we have the following facts and observations, which tend much to establish the identity of electricity and the nervous influence. Dr Colwards has proved, that electricity is necessary to muscular contraction, by the following simple experiment.

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The sciatic nerve of a frog ^{was} separated to a considerable distance from the surrounding parts, and supported by a non-conductor of electricity, when this separated part was subjected by any solid body, muscular contractions took place, though the limb was at the same time disconnected with the sensorium. But when the limb was supported by a conductor of electricity, there were no contractions in the limb, the fluid passing off to this conductor, instead of following the course of the nerve.

The phenomena of acupuncturation, a practice first adopted by the Japanese, and recently introduced into Europe and this country has thrown some light on this subject. In many painful nervous affections Rheumatism, &c, and in many cases of local inflammation, acupuncture has given almost immediate relief.

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The explanation of this phenomenon has been very difficult. Some, have attributed the relief obtained to counter irritation, and others to the imagination of the patient being strongly excited, but both of these explanations are unsatisfactory. The very slight irritation, or pain, produced by the operations, is a convincing proof, that the relief obtained is not to be attributed to counter irritation which has been used extensively, in some of the same cases, without the slightest benefit. And that the relief obtained is not dependent on the influence of the imagination has been proved by experiment.

It has been recently discovered that, in all cases where relief was obtained the needles exhibited strong marks of the galvanic influence; and, the probability is, that the relief is obtained by the needles

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moving as an electrical conductor to the superfluous animal electricity, an accumulation of which, in the part affected, constitutes the disease. Some of the French surgeons have recently proved this, beyond the possibility of a doubt, by the use of delicate Electrometers, which clearly indicated the escape of the fluid in such cases.

From all these facts, I think we are justified in concluding, that the nervous and electrical fluids are identical and, that electricity is the fluid which nature employs to occupy this important station in the human system. And surely a more suitable agent could not well be imagined; the rapidity, with which it passes through its conductors, is such

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ductors, it can only flow through those channels provided for its passage.

Occupying, as it does, so large a space in the great storehouse of nature; elicited and acting in all her operations, from the evaporation or condensation of a drop of water, to the explosion of a thunder cloud, this invisible and almost incomprehensible fluid, we must admit, a worthy instrument with which the mind of man may be connected with its proper materials.

How, it may be asked, can a fluid, which conveys but one impression produce all the modified actions of motion, sensation, and thought.

Mr Charles Bell has already established the fact, that different nervous fibres are employed for the conveyance of impressions, and the production of motions; and, it is probable that a trifling difference in the organisation of the instruments is sufficient to produce all their different modifications.

For example; light produces one impression on the Retina, and another on the Iris, and none on the surface of the body; whilst heat produces an impression on the surface of the body, and none on the Iris, or Retina; and yet, it is more than probable, that the nerves, which convey these impressions, are of the same organisation, and that the modifications of their impressions are the result of a different organisation in the part receiving the impression.

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Thus then we may consider, the brain and spinal marrow as the secreting organs of this subtle agent of the mind, which, seated at the centre of perception, conveys to, and receives from, the different parts of the system, the perceptions, impressions, and motions, which constitute the functions of the organic and animal lives.

All the intellectual operations, sentiments, and passions, and indeed every action connected with motion, sensation, or thought, are performed through, the agency of this secreted fluid. Every sensation, motion, and mental operation being performed by an expenditure of the nervous influence, a constant supply must be furnished by the brain and spinal marrow,

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and conducted by the nerves to the different parts of the system. These nerves are good conductors, and are isolated, in their course, by cellular substance.

In health, there is an equal distribution of this fluid to all the organs; and its unequal distribution is, in many cases, the cause of disease. If ^{too} large a proportion of it is expended, in the operations of the mind, the muscular system languishes, and the digestive organs are deranged for want of their necessary stimulus. For this reason, we find, that men of intense application are liable to all those diseases of the muscular and digestive systems which are dependent on a deficiency of the nervous fluid, as languor, dyspepsia,

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defective secretion of bile, and torpor of the bowels. And, in such cases, abstinence from mental exertion, and an increase of muscular exercise, will alone afford permanent relief.

From Magendie's Journal of Physiology, we have the following extract, which proves that an Electro Magnetic influence is derived from Acupuncture. Mr Pouillet, after making a complete circuit through a needle, and through the patient's mouth, found by means of a multiplier of Lebewegger with a magnetic needle, that the Electro Magnetic rotation could be readily produced at least, as far as to affect small vibrations backwards and forwards.

It may be enquired, what is the advantage to be derived from

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establishing the identity of the nervous influence
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As before stated, a large class
of diseases is dependant upon a deficiency
of the nervous influence or animal electricity.
This animal electricity, which is secreted,
we can neither control nor command;
but the mechanical which is identical,
we can control and command, and we
can substitute the one for the other.

This has been done by Sir W. Philip, M. Earley,
and others, in cases (in cases, of dyspepsia,
torpor of the secreting viscera, asthma,
paralysis, and other diseases dependant
on the same causes. In some of these
cases, the two poles were thus applied: the
positive to the back of the neck, and the
negative to the region of the stomach, and
the fluid was thus passed through the

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affected part. M. M. Bailey & Meyran, have lately made the needle the medium for introducing galvanism, by first applying the needle, as in acupuncture, and applying the positive pole to one needle, and the negative to the other. They considered this the most effectual way of applying galvanism.

Mr. Sarlandier resorted to galvanism to aid the action of the needles, by applying the negative pole only to the needles.

It has been suggested by Sir W. Philip, and practised by others with success, to apply the galvanism by two plates, the one of copper, and the other of zinc, worn with the ordinary dress.

Even the electricity, generated by wearing a silk and flannel garment together, might be useful in such cases.

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Another class of diseases, as spasmodic and local inflammatory, is, no doubt, produced or kept up by a superfluous quantity of electricity in the affected part. How this irregular distribution of animal electricity takes place, we pretend not to say; but we must admit the fact, that relief is, in many cases, afforded by acupuncture, which acts by taking off superfluous electricity.

The extent, to which the useful practical application of electricity to disease may be carried, is yet to be learned, though many cases of its utility are recorded in the modern periodical journals. It should be remembered, that the most important facts, on which this theory is founded, are of but recent discovery, and that time has not

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will be one of our most powerful remedial
agents, and that many diseases, now incurable,
will by their judicious application, be
placed entirely under the control of
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In the Spring, Summer and Autumn of 1827

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